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Map Reading

—U. S. Infantry Association

Map Reading

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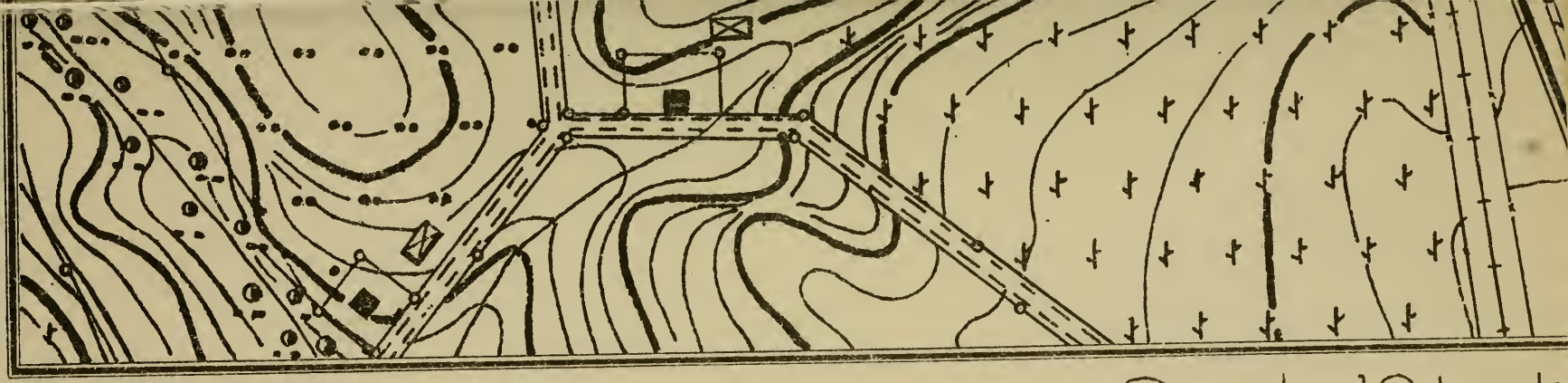
TOPOGRAPHICAL MAP

GETTYSBURG — ANTIETAM



Scale:12 Inch

0 1/4 1/2

1000 500 0

Scale of

Contour Interval 5 Feet. D

Published by the United Stat

Scale: 12 Inches – 1 Mile

0 1/4 1/2 3/4 1 Mile

1000 500 0 1000 Yards

Scale of Slopes

Contour Interval 5 Feet. Datum Mean Sea Level.

Published by the United States Infantry Association

443
427
400
420

Map Reading

GETTYSBURG WAR GAME MAP, SHEET P-11

Q. What is a military map?

A. A military map is one which shows the relative distance, direction and elevation of all objects of military importance in the area represented.

Q. What is map reading?

A. The ability to grasp the general features of the map and to form a clear mental picture of the ground represented by it.

Q. What are the essential elements of map reading?

A. 1. The conversion of map distances into corresponding ground distances: that is, an appreciation of the scale of a map.
2. An appreciation of compass direction.
3. A knowledge of the conventional signs and symbols employed by map makers to represent the various topographical features of the country included in the map.
4. A knowledge of contours and what they are intended to represent.

NOTE.—The map used in this conference on map reading is Sheet P-11 of the Emmittsburg quadrangle of the Gettysburg War Game Map prepared at the Army Service Schools, Fort Leavenworth, Kansas.

SCALES

Q. What is the scale of the map?

A. Twelve inches equal one mile.

Q. What do you understand by the statement "12 inches equal one mile?"

A. That 12 inches measured in any direction on the map represents one corresponding mile on the ground; that any 6 inches measured on the map represents ½ mile on the ground. In other words, the scale of a map is the ratio between two points on the map and the corresponding points on the ground.

Q. In what ways may the scale of a map be expressed?

A. 1. By a plain statement in words and figures as given in the previous answer: "12 inches equal 1 mile."
2. Graphically, that is, by drawing a line on the map, dividing it into equal parts and marking them, not with their actual lengths, but with the map distance that they represent.
3. By a Representative Fraction, contracted in practice to R. F.

Q. You note that the R. F. for our map is not stated. What is it?

A. The R. F. of our map is 1/5280. For convenience expressed R. F. 1: 5280.

Q. How do you arrive at this conclusion?

A. A R. F. is a fraction reduced to unity in which the numerator represents the map distance and the denominator represents the ground distance both in the same unit of measure. We know that our map is 12 inches to 1 mile. We make a fraction thus:

$$\frac{\text{Map Distance}}{\text{Ground Distance}} = \frac{12 \text{ inches}}{1 \text{ mile}} =$$

$$\frac{12 \text{ inches}}{63{,}360 \text{ inches}} = \frac{1}{5280}$$

This means that any one unit of measure on the map will represent 5,280 of the like units on the ground. To prove this we have 12 inches or one foot on the map represents one mile or 5,280 feet on the ground.

Q. What scales are prescribed by the War Department in making military maps and sketches.

A. 1. For maps on which the organization of defensive positions are shown: 12 inches to 1 mile. Our war game maps are made on this scale.
2. For position maps, place and outpost sketches, 6 inches to 1 mile.
3. For road maps and sketches, 3 inches to 1 mile.
4. For strategic maps, 1 inch to 1 mile.

NOTE.—Our Geological Survey maps are drawn on R. F. 1: 62,500, which is nearly 1 inch to 1 mile. To be exactly 1 inch to 1 mile they would have an R. F. of 1: 63,360.

Q. What are the two classes of map scales?

A. 1. Working scales.
2. Reading scales.

Q. What is a working scale?

A. The scale used by the topographer in making the map, as paces, strides, feet, lengths of a chain or rope, revolutions of a wheel, etc.

Q. What is a reading scale?

A. A reading scale is one used in laying off dis-

tances on the map. It is in a standard unit of measure with which we are familiar, such as miles, yards, feet, etc.

NOTE.—In some cases the working and reading scales may be identical, as when the topographer measures his distances on the ground in yards and our reading scale is also in yards.

Q. Suppose you have a map that has no graphical scale line on it but has an R. F. or a statement that so many inches equal one mile. How would you go about measuring distances between points on the map?

A. It would be necessary to construct a graphical scale.

NOTE.—Modern maps usually have a graphical scale on them. Should they not, it is a very simple matter to solve a scale problem and construct a scale provided you have the R. F. or data from which you can deduce it. With the following simple formula any scale problem may be solved.

Let m = the number of units of measure to be represented by the scale line. In linear scales make this always even 1,000 or 2,000, so there is nothing further to remember.

Let p = the number of inches in the unit of measure. For a scale of yards p would be 36, for a scale of 30-inch paces p would be 30, for a scale of meters p would be 39.37.

Let n = the denominator of the representative fraction. For 12 inches to the mile n would be 5,280.

Let x = the number of inches in the scale line to represent m units of measure.

Then: $\frac{m \text{ times } p}{n} = x.$

Or, if you prefer a rule, the following is applicable: Multiply the number of units of measure in the scale line by the number of inches in the unit of measure and divide by the denominator of the R. F. The quotient will be the number of inches in the scale line. Applying the formula, let us work out the scale of yards for our map.

m = 1,000 yards, the number of units of measure to be represented by the scale line.

p = 36 inches, the number of inches in the unit of measure.

n = 5,280, the denominator of the R. F.

Then m times p, divided by $n = x$.

x = 6.81, the number of inches in the scale line to represent 1,000 yards.

Draw a line 6.81 inches long. Divide it into five equal parts, each representing 200 yards. Divide the left division into two equal parts, each representing 100 yards. You have your scale ready for use.

EXAMPLE.—You have determined your pace to be 30 inches, your stride is therefore 60 inches. Construct a scale of strides, 3 inches to 1 mile.

m = 1,000 strides. That is, the scale, when completed, will represent 1,000 strides.

p = 60 inches.

n = 21,120, the denominator of the R. F. 3 inches = 1 mile.

x = length of the scale line in inches. Then: 1,000 times 60, divided by 21,120 = 2.84 inches. Therefore a line 2.84 inches long will represent 1,000 strides on a scale of 3 inches = 1 mile.

CONSTRUCTION.—Draw a line 2.84 inches long. Divide it into five equal parts. Each part will represent 200 strides. Divide the left-hand part into eight equal parts. Each part will represent 25 strides. You have a scale of strides of 60 inches at 3 inches to 1 mile, complete and ready for use.

The method of dividing the line into equal parts is shown in Fig. 1.

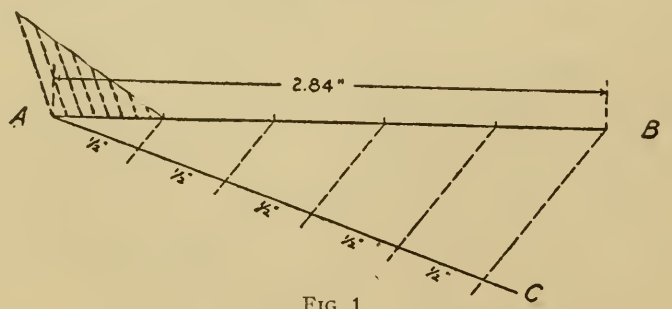


FIG. 1.

The line *A*—*B* is 2.84 inches long. We want to divide it into five equal parts. Draw the line *A*—*C* at any convenient angle to *A*—*B*, and of a suitable length. On the line *A*—*C* lay off five equal spaces from *A*. Now, draw a line from the fifth point on *A*—*C* to *B*. Draw lines parallel to this line through the other four points on *A*—*C* and extend them upward until they cut the line *A*—*B*. This process also divides *A*—*B* into five equal parts. Each of these parts will represent 200 strides.

In a similar manner divide the left-hand division into eight equal parts as shown in the illustration.

Now, erase all the lines except the finished line *A*—*B* and you have the complete working scale as shown in Fig. 2.

Q. What is the distance from road fork 443 *to road fork* 395, *via* 428.

A. 2,775 yards.

Q. You have two machine guns on top of hill 462. *You observe a mounted patrol on the unimproved road at the farmhouses at A. You decide to open fire. What range would you give your gunners?*

A. Range, 960 yards.

Q. You are in command of a combat patrol of one squad. You have arrived on the hill at B southeast of the Clagett farmhouses. You observe a small body of the enemy engaged in the destruction of the railroad bridge at C. You decide to open fire. What range would you give?

A. Range, 600 yards.

Fig. 2.

Q. How do you determine the distance between two points on the map?

A. 1. By measuring along the edge of a piece of paper the distance between the two points and applying that distance to the graphic scale on the map, and reading directly from it.

2. To measure the distance from one point to another along a winding road or course place the edge of the paper along each straight stretch, placing the point of a pencil or pin at the edge of the paper at each such successive point where the direction changes and shift the edge of the paper around to follow the courses until the total distance has been covered. Apply this total distance to the scale of the map and read direct.

3. The distance may be measured by a pair of dividers as follows: Place leg No. 1 of the dividers at the initial point; spread leg 2 out to the first change of direction; holding leg 2 in place, swing leg 1 around until a line between the points of the two legs is in prolongation of the next course; then holding leg 1 in place, spread leg 2 out to cover the course. You thus have your first and second stretches of the distance accurately laid off between the points of your dividers. Continue this process until the entire course is covered; apply the distance to the graphic scale on your map and read direct.

Q. Your platoon is marching via the 443-415-428-395-383 *road. It has halted for the regular hourly rest at the road fork* 443. *It is now* 9 *a. m. You continue the march. At what time will you reach road fork* 383?

A. The distance is 3,580 yards. Marching at the rate of 80 yards per minute the platoon will march 45 minutes, and will reach road fork 383 at 9.45 a. m.

DIRECTION

Q. How is the north point of a map indicated?

A. By a line placed on the map at a convenient place with an arrow pointing to the north.

Q. On our map there is no line showing the north. How would you determine which is north?

A. When we get a map with no north line on it we can usually safely assume that the reading on the map runs east and west. This makes the sides of the map as we look at it run north and south. The top is north, the right-hand side east, the left-hand side west, and the bottom south. This is exactly the case with the map on which this conference is based.

Q. How is the direction of one point from another stated in military map reading?

A. By the points of the compass. One point is said to be north, east, south or west from another point. When it lies between the north and east points it is said to be

north (so many degrees) east; when between the east and south it is said to be south (so many degrees) east; when between the south and west it is said to be south (so many degrees) west, and when it is between the west and north it is said to be north (so many degrees) west.

Q. What is the direction of 395 *from* 428?

A. It is east.

Q. What is the direction of 383 *from* 443?

A. It is north 45 degrees east.

Q. What is the direction of road fork 443 from 415?

A. It is south 20 degrees east.

Q. What is the direction of 427 *from road fork* 443?

A. It is west.

Q. What do you understand by orienting a map?

A. Placing the map in such position that every road, stream, or other feature on the map will be parallel to its actual position on the ground; in other words, to make the map and the ground it represents coincide.

Q. What are the objects of orienting the map?

A. To enable you to pick out and identify on the ground all the features shown on the map.

Q. By what methods may a map be oriented?

A. 1. When the map has a magnetic meridian on it: Place the north and south line of compass parallel to the magnetic meridian and turn the map until the north end of the needle points to the north of the circle. If the true meridian only is shown on the map, you must know the declination and make allowance for it. If the declination is not more than 4 or 5 degrees, the orientation on the true meridian or along the up and down borders of the map will be sufficiently accurate for all practical purposes.

2. When you have no compass or the meridian is not known on the map: (*a*) If you can locate on the map your position on the ground and can identify another place on the map which you can see on the ground, shift the map around until the two points on the map are aligned on the distant point on the ground and you have the map oriented. (*b*) By reference to a straight road or line of railway on which you may be standing, turn the map until the conventional symbol points in the same direction as the feature that it represents. In both of these methods the points used for orientation should be as far apart as possible, and in any case they should be more than an inch apart on the map.

Q. How would you locate your position on the map?

A. 1. When the map has been oriented by compass. Sight along the ruler at an object on the ground, at the same time keeping the ruler on the plotted position of this same object on the map. Draw a line towards yourself. Locate another point on the ground that is plotted on the map and repeat the process. The intersection of these two lines is your map position. These lines should form an angle of not less than 30 degrees and not more than 150 degrees. Get the angle as nearly 90 degrees as practicable.

2. If the map has been oriented by means of a straight line drawn between two map points, it will be necessary to draw but one line from an object on the ground, and the intersection of this line with the line already on the map will be your location on the map.

Q. Suppose you are at the railroad bridge at C. How would you orient your map?

A. Turn the map so that the railroad runs in prolongation of the line on the map that represents it, and your map is oriented.

Q. You are standing on hill 462 *where there is no well-defined feature on which to orient your map. You have a box compass. How would you orient?*

A. Lay the compass on the map with its box edge parallel to the sides of the map—the 0–360 point towards the top of the map. Now turn the map until the compass needle reads zero, and your map is oriented.

Q. You are out in the open fields on the high ground about 900 *yards east of the Clagett farm. You have a compass. You want to get your location on the map approximately accurate. How would you go about it?*

A. First orient your map with the compass as explained above. Now lay a ruler on the map, pivot it on the Clagett house on the map, and sight it at the Clagett house on the ground. Draw a line

towards yourself. You are on this line somewhere. Now go around to the top side of the map and in like manner pivot your ruler on the map location of the farmhouse at C and point it at the farmhouse on the ground. Draw a line towards yourself. Your position is also on this line somewhere. At the intersection of the two lines is your position. This process is technically called "resection."

Q. You are traversing (walking) along the road 395–428, you see a point on the high ground to the south that you want to locate on your map without going over there. How would you do it?

A. At 395 orient your map. Pivot your ruler at 395 and sight it on the distant point. Draw a line. The point must be on this line somewhere. When you get to 428 repeat the process, that is, orient your map, pivot your ruler on 428 and sight on the distant point. Draw a line. The point must also be on this line. Where the two lines intersect is the location of the distant point on the map. This is what is technically known as "intersection."

CONVENTIONAL SIGNS

Q. How are the topographical features of the country included in a map shown?

A. By means of conventional signs that all persons essaying to use the map should be familiar with.

Q. What is the characteristic of these conventional signs?

A. They are drawn as nearly as practicable to resemble the features on the ground that they represent.

NOTE.—The conventional signs are the A, B, C's of map reading. You must be absolutely familiar with them if you would read a map. One of the best methods of learning them is to practice making them at odd moments until you are familiar with all of them.

The following illustrations (Fig. 3) show the system of conventional signs employed in making the Gettysburg war game maps and their 3 inches to 1 mile reproductions. Study and practice them until you learn them thoroughly.

Q. Locate an improved road.

A. The 395–428 road.

Q. Locate an unimproved road.

A. The road leading to the southwest from 415.

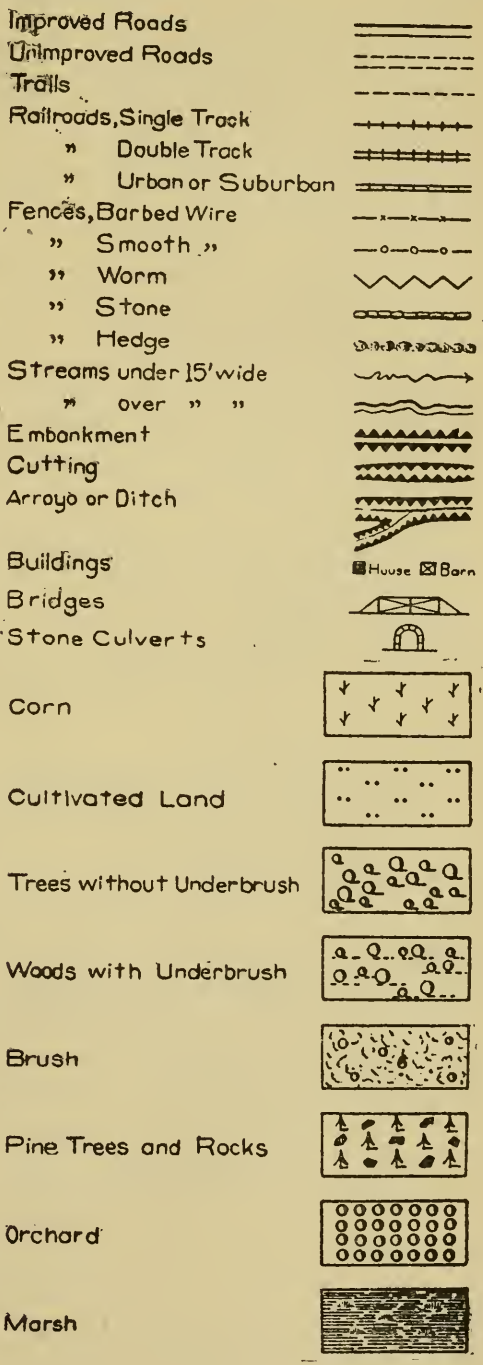


FIG. 3.

Q. Locate a single railroad.

A. That paralleling the 443–415–428 road.

Q. Locate a barbed-wire fence.

A. Fence paralleling railroad and to east of it.
Q. Locate a smooth-wire fence.
A. The fence along almost any road on the map.
Q. Locate a stream under 15 feet wide.
A. That running east and west through the north central part of the map.
Q. Locate a stream over 15 feet wide.
A. In the southeast corner of the map.
Q. Locate embankments and cuts.
A. See those along the railroad.
Q. Locate a bridge.
A. That at C on the railroad.
Q. Locate houses and barns.
A. The Clagett farm south of 415.
Q. Locate corn land.
A. The big field northwest of the Clagett farmhouses.
Q. Locate cultivated land.
A. North and south of hill 462.
Q. Locate forest land.
A. Along the west slope of the valley running south from 383.
Q. Locate an orchard.
A. East of road fork 428.

CONTOURS

Q. What are contours?
A. They are lines of equal elevation. Lines cut from the surface of the earth by imaginary horizontal planes at an equal vertical distance from each other.
Q. What do contours show?
A. 1. The relative elevation of all points on the map.
2. The slope of the ground between any two points on the map.
3. The shape and form of the ground included in the area covered by the map.
Q. What are the principal characteristics of contours?
1. All contours either join or both ends extend to the edge of the map. When they join they either represent a hill top or a depression—a hill when the smallest closed contour is higher than the next one to it and a depression when it is lower.
2. Where the contours are equally spaced the slope is uniform. Where they are close together the ground is steep, and where they are wide apart the slope is gradual.
3. A watershed is the high ground between two water courses. The water flows away from it on both sides and is indicated by the higher contours bulging out towards the lower ones.
4. A water course is the low ground between two watersheds. The drainage from both sides of it joins in one stream and is indicated by the contours bending sharply towards the higher ones.
5. A sadle or col is the space between the summits of two adjacent hills. It is indicated by two contours of greater elevation on two sides of it and two of lesser elevation on the other two sides.
6. A spur is an under feature that projects out from one of the main topographical features.

Q. You see at the bottom of the map a statement "Scale of Slopes," and underneath it a line divided up into parts and each part marked 1°, 2°, 3', etc. What do you understand this means?
A. This is what is technically called a scale of "Horizontal Equivalents." It is used in map making to locate contour points on the map and is used in map reading to determine the slope of the ground at any point. We know that the ground will rise 1 foot on a one-degree slope in 57.3 feet, and that it will rise 5 feet in 5 times 57.3, or 286.5 feet. We simply measure off 286.5 feet or 95.5 yards, and that is the H. E. for 1 degree. Test this by measuring off the scale of slope for 1 degree and apply it to the graphical scale on the map, and you will find that it measures 95.5 yards. Now to find the H. E. for the other degrees we simply divide the 95.5 by the numbers 2, 3, 4, etc., and lay off the quotient on the scale of slopes.
Q. Just below the scale of slopes we have the statement "Contour interval 5 feet." What do you understand by that?
A. It means that the vertical distance between contours on the map is 5 feet. That if the contours were marked on the ground one would be 5 feet vertically above the other.
Q. You also see the statement "Datum mean sea level." What does this mean?
A. That all the points on the map are so many feet above the level of the sea. It means that hill 462 is 462 feet above the mean level of the Atlantic Ocean.
Q. Locate a watershed on the map.
A. The ridge running north and south near the eastern edge of the map. The

farmhouses at A are on the top of the watershed. Trace out the 445-foot contour on this watershed and see how it runs.

Q. Locate a water course.

A. The stream running across the map from south to north through the east central part of the map. Trace it out and see the watersheds that it lies between.

Q. Where is the steepest ground on the map?

A. On the wooded slopes of the watershed to the east of farmhouses at A.

Q. Where is the most generally gently sloping ground on the map?

A. In the cultivated fields in the northwest corner of the map.

Q. Trace out the 440-foot contour and see how it runs on the map.

A. We note that the 440-contour comes on the map at the southeast corner, runs north to the end of the watershed, then doubles back along the west side of the watershed, winds its way to the north of hill 462 and then towards the northwest, where it leaves the map. It comes on the map again at the western edge north of hill 443, comes by Clagett farm, runs by road fork 443, thence south, and leaves the map at the south edge just west of the railroad. Again, small portions of it come on and leave the map at the north edge.

Q. Can you see road fork 415 from road fork 443?

A. No. The high ground southeast of the Clagett farmhouses intercepts the line of sight.

Q. Can you see road fork 383 from hill 462?

A. Yes. There is no higher ground lying between the two points.

Q. Can you see the Clagett farmhouses from the farmhouses at A?

A. Yes.

Q. When there is doubt regarding the visibility of one point from another how can you determine the matter definitely?

A. By making a profile along the line of sight.

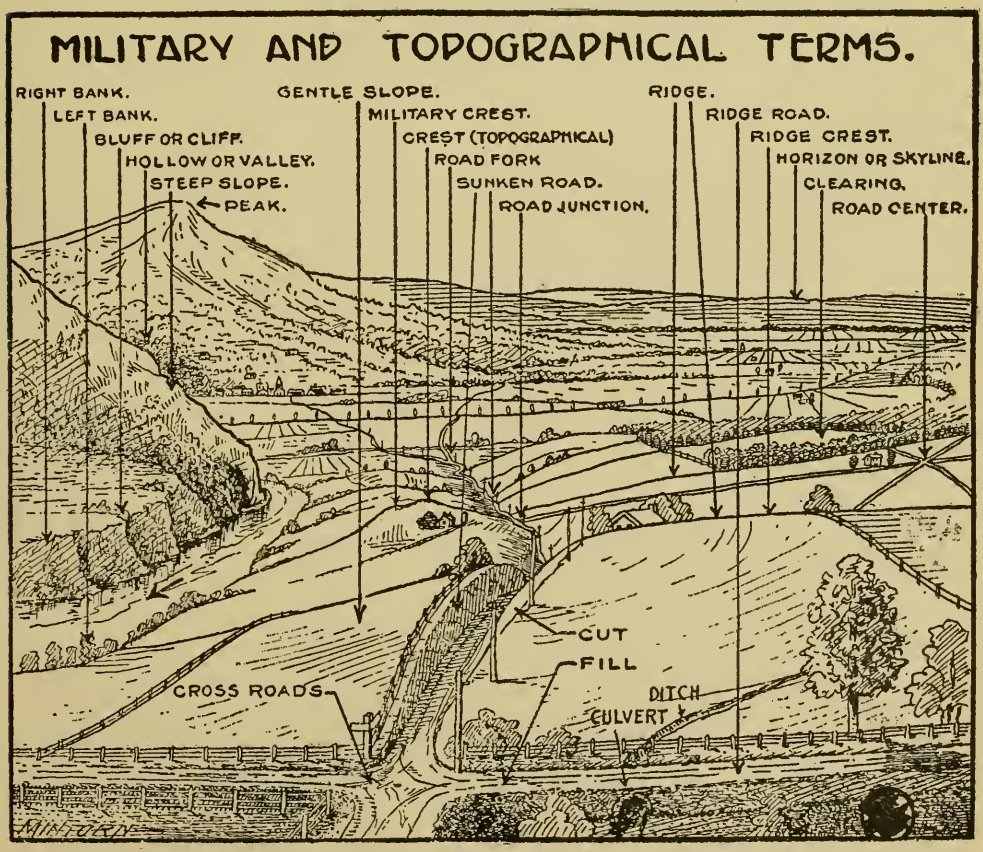


FIG. 4.

This is made by plotting to scale on a piece of profile or cross-section paper: (a) The point from which the observation is made, (b) the point to be observed, and (c) any point that may intercept the line of sight.

Draw a line from (a) to (b), the platted points. If it touches (c) the points are not intervisible. If it does not touch (c) they are visible one from the other.

NOTE: Fig. 5 shows the method of constructing a profile along the line (a)—(b) on the map with point (c) intercepting. The point (b) is not visible from (a). Get some cross-section paper at a stationery store and plot several profile lines as given on the map (d) to (e) and (f) to (g). Note that where the contours are close together on the map the line on the profile is very steep and that where the contours are far apart on the map the profile line is not so steep. By a careful study of profile lines you can gain much knowledge of contours and what they represent.

Q. Where would you post a sentinel on hill 462 *to get the most extended view to the north?*

A. At the north point of the hill just west of (c).

Q. What is the slope of the ground between x and y?

A. One degree. Apply the scale of slopes between adjacent contours and you can determine the slope at any point on the map. The shape of the contours will give you the conformation of the ground at any point.

PRACTICAL PROBLEMS IN MAP READING

Map: P-11—Section Emmitsburg Map

NOTE.—In the solution of the following ten problems disregard the scale and vertical interval of the map.

SCALES

Q. The range from the Clagett farmhouse to the railroad culvert at C is 1,000 *yards. Construct a scale of yards for the map. What is the R. F.?*

Q. How long will it take a company to march from the barn at A to road fork 443, *via* 383 *and* 428, *marching at the rate of* 88 *yards per minute and making the regular halts? The R. F. of the map is* 1:21,120.

Q. The map is 4 *inches to one mile. What is the distance as a crow flies from the barn at A to the following points: Cross-roads* 443; *Point (a); the Clagett farmhouse; road fork* 428?

Q. A cyclist moving at the rate of 12 *miles per hour travels from road fork* 443 *to road fork* 415 *in* 9½ *minutes. Construct a scale of yards for the map.*

Q. Sound travels at the rate of 1,100 *feet per second. How soon afterwards would the report of a rifle fired at road fork* 395 *be heard at (a) and road fork* 427 *respectively? R. F. of map is* 1:5,000.

Q. The R. F. of the map is 1:20,000. *The stream running east and west across the north central part of the map flows at the rate of* 2 *miles per hour. How long will it take a plank to drift from the railroad culvert at c to the bridge just north of* 383?

Q. Companies of infantry bivouacked at A and road fork 427, *respectively, are ordered to rendezvous at road fork* 428 *at* 11.45 *a. m. At what time will they have to start marching? The scale of the map is* 3 *inches to* 1 *mile.*

Q. What is the distance in meters from 383 *to* 427 *via the* 395-428-415 *road? Scale of map is* 6 *inches to* 1 *mile. A meter is* 39.37 *inches.*

Q. If the distance from (f) to (g) is 1,000 *meters construct a scale of yards for the map.*

Q. The map is 12 *inches to* 1 *mile. In pacing from* 395 *to* 428 *you take* 1,118 *paces; from (e) to (d) you take* 1,350 *paces; via the main road from* 427 *to* 443 *you take 1,230 paces; from 443 across country to the barn at A you take* 1,400 *paces. What is the length of your pace?*

DIRECTION

Q. Let us say the line (d)–(e) is magnetic north and south. What is the compass bearing of the following points from road fork 443: *the barn at A;* 383; 415; *Hill* 462; 427; *Hill* 443? (*Note: Draw a line through* 443 *parallel to the line (d)–(e). Draw radiating line from road fork* 443 *to the points indicated. Apply the protractor and read the bearings direct.*) (*Cut out the protractor on the sheet of cardboard for solving these problems.*)

Q. The side borders of the map run magnetic north and south. A scout marching at the rate of 80 *yards per minute leaves the barn at A, proceeds on a bearing of* 260° *for* 9 *minutes; thence* 350° *for* 7 *minutes; thence* 300° *for* 5 *minutes; thence* 40° *for*

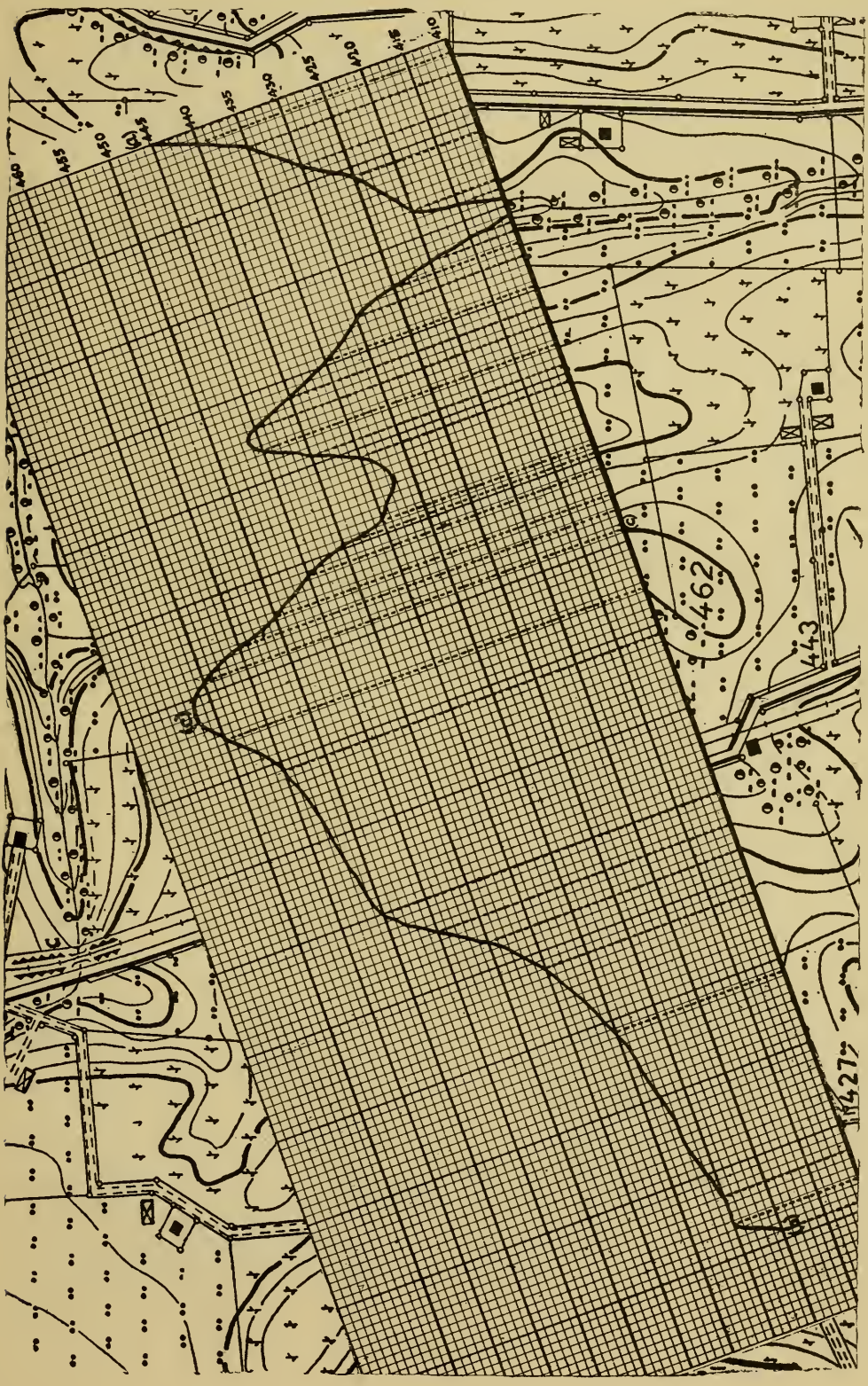


Fig 5.

9 minutes. Locate his position on the map. What is the bearing from this point back to the point of starting (the barn at A)?

Q. The side borders of the map run true north and south. The declination is 7° west. A scout starting from road fork 427 marches on a compass bearing 38°. At what point will he leave the map?

Q. The side borders of the map run true north and south. The declination is 7° west. A battalion is in approach march formation with the first platoon of Company A as base platoon. The base squad of this platoon is at (c). The compass bearing of the directing line is 310°. At what point will the base squad cross the railroad?

Q. An observer standing at (c) finds that the compass reading to road fork 395 is 80°. What is the true direction of the following points from (f), assuming the declination to be 10° west: the barn at A; road fork 443; road fork 427; road fork 428; the Clagett farmhouse; point (a)?

Q. The side borders of the map run true north and south. The declination is 4° west. Scale of map 12 inches to 1 mile. Two scouts start from (c); Scout A marches on a compass bearing of 40° for a distance of 1,400 yards; Scout B marches on a compass bearing of 320° for a distance of 1,200 yards. How far apart are the two scouts? What is the compass bearing of Scout A from Scout B? Can Scout A see Scout B?

Q. The side borders of the map run true north and south. An observer at (g) takes a compass bearing on (c), which reads 193°; what is the declination? Based on the declination thus determined, what is the compass bearing of 383 from 415?

Q. The side borders of the map run true north and south. The declination is 8° east. A scout arrives at road fork 428 and decides to march directly on the barn at A. What is the compass bearing that he will march on?

Q. The line (f)–(g) is magnetic north and south. Its declination is 7° west. A scout marches true south from 415 for a distance of 1000 yards; thence on a compass bearing of 100° for a distance of 1,200 yards; thence on a compass bearing of 37° for a distance of 800 yards. What compass bearing will he have to march on to get back to his starting point?

Q. The side borders of the map are true north and south. An observer finds that the true bearing of 383 is 51° and 428 is 308°. Show his position on the map.

Q. The line (c)–(a) is magnetic east and west (a) to the east. A scout at the barn at A takes a compass bearing on a windmill which is 167°; on arriving at (c) he takes another compass bearing on the same point which is 88°. Locate the windmill on the map.

Q. The side borders of the map are true north and south. The declination is 7° W. An observer at (a) reports an enemy machine-gun nest at a compass bearing of 345°. Another observer at (c) reports the same machine-gun nest at a compass bearing of 24°. What is the direction of the machine-gun nest from a battery of artillery at road fork 427? What is the range? Scale of map 6 inches to 1 mile.

Q. The line (f)–(g) is magnetic north and south, (g) north. A compass bearing to road fork 427 reads 165°; another compass bearing to the farmhouse north of hill 443 reads 275°. Locate the point on the map from which these bearings were taken.

Q. The side borders of the map run true north and south. The declination is 7° west. A scout is on the 443–415 road. He takes a compass bearing to (f) which reads 100°. Where is the scout on the road?

CONTOURS

Q. If the contour at (c) is 120 feet and that at (f) is 40 feet, what is the Vertical Interval?

Q. If the contour at x is 640 state the elevation of the following points: Clagett farmhouse; road fork 395; road fork 428; (a); (e); road fork 443; the barn at A.

Q. Examine the line (d)–(e). Where is the gentlest and steepest slope on it?

Q. Mark the heights of the contours on a line drawn from the Clagett farmhouse to the barn at A. The contour at (c) is 320. The Vertical Interval is 10 feet.

Q. Suppose the heights of (g) and (f) to be 600 and 760 respectively. What are the heights of the contours nearest the following points: 383; 428; 443; 462; 427?

Q. An aviator is 800 feet above 383 and travel

in a straight line southwest across the map. If he maintains the same level throughout the flight what is his height above the ground when he leaves the southwest corner of the map? The V. I. is 20 *feet.*

Q. Mark the heights of all contours cut by a line from (*e*) *to* (*c*). (*V. I.* 10 *feet; the elevation of* (*g*) *is* 470.)

NOTE.—In the following problems the scale of map is 12 inches to 1 mile. The V. I. is 5 feet.

Q. State whether the following slopes are concave or convex: From the barn at A to the stream 250 *yards to the west; from* (*f*) *to the stream* 700 *yards to the north (sighting along the line* (*f*)–(*g*)).

Q. Could a man standing at (*c*) *see others at the barn at A; at* 427; *at the Clagett farmhouse; at* 415; *at* 383; *at* 395; *at* (*a*)?

Q. Standing at (*c*) *with the eye* 5 *ft. above the ground and looking at* (*f*), *where will the line of sight strike the ground? Standing at the barn at A with the eye* 5 *feet above the ground and looking at* (*f*), *where will the line of sight strike the ground?*

Q. A scout has reached (*a*); *will he be able to see* 383; *A;* (*g*); 415; *the Clagett farmhouse;* 443; 427; *Hill* 462?

Q. What must be the height of a flag-staff at the Clagett house to be visible from the barn at A?

Q. Where would you establish visual signal stations in order to communicate between 427 *and* 383?

Q. A scout is in the cupola of the barn at A, 45 *feet above the ground. He is watching the road leading towards* 383. *At what point on the road will a hostile patrol moving south come into view?*

Q. A scout is in a tree 15 feet above the ground at the southeast corner of the orchard east of 428 *observing the* 428–383 *road. At what points on this road would a hostile patrol marching west from* 383 *be visible? At what parts of the road would they be hidden from view?*

Q. When an aeroplane was over (*d*) *the bridge at* 383 *was just visible. At what height was the plane flying above* (*d*)?

Q. Could a patrol go from A to C without coming under the observation of a hostile scout at (*c*)? *Show the route.*

Q. Draw a line from (*e*) *to* (*c*) *and make a cross-section.*

Q. Make a cross-section along the road 428–395. *Show which slopes are convex and which are concave.*

CONVENTIONAL SIGNS

Q. Draw a square 4 *inches on a side and make a sketch map embracing the following features:*

a. A single track railroad running from west to east across the center.

b. A telegraph line parallels the railroad on the north side.

c. A stream crosses the map from southwest to northeast, flowing northeast.

d. An improved road runs north and south across the map, crossing the stream and railroad east of the center of the map.

e. An unimproved road runs east and west across the map one inch south of the railroad. Crosses stream at a ford.

f. Two smaller streams running from the north and two from the south enter the main stream. One from each direction across the railroad.

g. The elevation at the point where the main stream leaves the map is 500 *feet. At the point where it enters the map (southwest corner)* 535 *feet. Fill in the* 510, 520, 530, 540 *and* 550 *contours. The highest point on the map has an elevation of* 555 *feet.*

h. Show the cuts and fills along the railroad.

i. The rectangle formed by the railroad, improved road north and east edge of map is covered with meadow land with trees scattered here and there and quite numerous along the stream. The rectangle to the south of that just described is wooded country. The triangle bounded by the main stream, the improved road and the unimproved road is covered with an orchard. A farmhouse with barn is at the crossroads. The rest of country to the south of the unimproved road is cultivated in corn and wheat. Fill in the remainder of the map with appropriate conventional signs of your own choosing, employing the signs for the various classes of fences, and vegetation covering the ground.

Q. Practice drawing the conventional signs shown in Fig. 3.

Q. Draw a sketch showing the water system of an area and fill in the contours to correspond thereto.

Practical Problems in Map Reading

Map: Emmitsburg Sheet

SCALES

Q. *What is the scale of this map expressed in inches to the mile?*

Q. *You want a scale of meters for this map. How would you go about getting it (a meter is 39.37 inches)? Try out the formula.*

Q. *What is the distance from the road fork at Four Points to road fork 481 at Longs via the 365–405–468–481 road?*

Q. *You have two machine guns on hill 442. (south 30 degrees west from Four Points). You have located an enemy detachment at Martin's Mill. You decide to open fire. What range do you give your gunners?*

Q. *What is the distance from road fork 481 at Longs to Fair Play via Emmittsburg?*

Q. *Your platoon is bivouacked at Four Points. It has been ordered to rendezvous at road fork 443 (on the Frederick Turnpike) at 9.37 a. m. What time will you have to start your march?*

Q. *Your company has been ordered to entrain at Emmittsburg at 10.47 a. m. You are required to be at the entraining point 30 minutes before the time designated. You are bivouacked at Thomas Creek Church. All roads are available for your march. What time will you start marching?*

Q. *Your platoon is marching south on the Fairplay-Emmittsburg-Longs road. You start from the cross roads at Fairplay at 9.00. At what time will you pass road fork 488, road fork 422 (west of St. Joseph's College), cross-roads 466 (west of Motters)? Where will you make a halt?*

Q. *A sketcher takes paces of 32.2 inches. Construct a working scale of paces at 6 inches to one mile.*

Q. *A sketcher is making a road map at a scale of 3 inches to 1 mile. He is measuring his distances by counting the revolutions of a 40-inch wheel. Construct a working scale. Construct a reading scale for this sketch to read yards.*

Q. *Your platoon is at the bridge over the Monocacy near the Stull farm. It is now 9 a. m. You are ordered to march via the 383–420–365–405–468–453–Emmitsburg–Fairplay road to Fairplay. At what hour will you pass 468; and 488? Where will you make your regular hourly halts?*

Q. *Your company (less one platoon) is at Fairplay. The detached platoon at road fork 444. You are ordered to be at the railroad station at Emmitsburg at 10.38 a. m. At what hour will each element of the company have to start its march.*

Q. *How far will a man march in going from the bridge northwest of Stull farm to Motters via 383–420–Four Points–365–418–387 road?*

Q. *The head of your column is now at the cross roads at Fairplay. It is ordered to be at cross-roads 446 west of Motters at 9.27 a. m. What time will you have to start marching?*

Q. *How long will it take a column to march from Fairplay to Motters by the shortest route?*

Q. *It is known that the enemy has a battery of 75s at road fork 428 (south of Motters). It has an effective range of 5,000 yards. You have a battalion of infantry on the Stull–452 road with the head of the column at the bridge over the Monocacy northwest of Stull. You are ordered to march to Emmitsburg.*

Q. *Where would you place machine guns on the east of Four Points to cover the bridges over the Mill Run and Tom's Creek at Four Points?*

Q. *You have a French map that has a scale of meters on it. You lay off 2 inches on the scale and find that it reads 1,016 meters. Construct a reading scale of yards for the map.*

Q. *You have been ordered out to make a road sketch mounted. You have tested your horse and find that he travels at the rate of 5¼ miles per hour. The scale of your sketch is to be 3 inches to 1 mile. Construct a working scale to read minutes and half minutes.*

Q. *You take a pace of 33.4 inches. You have a map on which the legend and scale have been torn off. You pace the distance between two points on the ground and find it to be 1,500 paces. You measure this corresponding distance on the map and find it to be 2⅜ inches. Construct a reading scale of yards for the map.*

DIRECTION

Q. *What is the direction one from the other of the following points: Emmittsburg from Longs; Fairplay from Emmittsburg; Four Points from Longs; Motters from Four Points; Martin's Mill from Cumps Mill; St. Joseph College from Cumps Mill; St. Joseph's College from Four Points?*

Q. *You are somewhere on the high open ground east of Longs. You have a compass. How would you go about locating your place so as to indicate it on your map?*

Q. *You are reconnoitering along the road from Thomas Creek Church north to* 449. *You discover a machine-gun nest across Toms Creek in the edge of the woods east of hill* 469. *How would you locate it definitely on a map to send back with a message?*

Q. *You are somewhere in the open field north of hill* 487 *(east of Longs). You have your map and compass. Explain how you would go about the task of locating your position accurately on the map.*

Q. *Our line runs along the high ground* 420–*Thomas Creek Church*–449–*hill* 466. *We have observation stations at Thomas Creek Church and at* 449. *An enemy machine-gun nest has been discovered on hill* 469. *Explain how you would go about the task of platting its location accurately on the map.*

Q. *What is the direction of the following points from the road fork at Motters: St. Mary's College; Fairplay; Stull; Clagett; Lime Kiln at road fork* 462?

Q. *Describe the meanderings of Tom's Creek, using compass directions, from Cump's Mill to its mouth.*

Q. *You are going across country from Longs to Cumps Mill. What is your compass reading?*

CONVENTIONAL SIGNS

Q. *Locate the following by conventional signs:*

1. *Improved road bordered by smooth wire fence.*
2. *Unimproved road.*
3. *Railroad. Is it single or double track?*
4. *Various classes of fences.*
5. *Streams over* 15 *feet and under* 15 *feet wide.*
6. *Embankments, cuts and arroyos.*
7. *Buildings.*
8. *Bridges.*
9. *Corn, cultivated land.*
10. *Wooded country.*
11. *Orchards.*

Q. *Locate the following ground forms on the map: A hill, a spur, a saddle or col, a watershed, a water course.*

Q. *You are standing at road fork* 453 *north of Longs. Draw a line from your position to Cumps Mill and another to the Orendorf farmhouse. Describe the country included in the area bounded by these two lines as shown by the conventional signs.*

Q. *Draw the following named conventional signs without consulting the map.*

a. *An improved road bounded on one side by a barb wire fence and on the other by a smooth wire fence.*
b. *An unimproved road bounded on one side by a worm fence and on the other by a stone fence.*
c. *An improved road having an embankment on one side and a fill on the other.*
d. *A stream over* 15 *feet wide with steep banks.*
e. *A stream with an improved road crossing it on a stone culvert.*
f. *A double track railroad running through a cut.*
g. *A woods with underbrush with an unimproved road running through it.*
h. *A space* 2 *inches square with each of the following vegetation: corn, cultivated land, orchard, marsh land, cleared woods.*
i. *Outline a drainage system and draw in the contours to show hills, cols, spurs, steep slope and gradual slope.*

CONTOURS

Q. *With a red crayola trace out the* 440*-foot contour. This is the master contour of the map. From this you will be able to get the lay of the land.*

Q. *With a blue crayola trace out the important streams.*

Q. *With a green crayola trace out the* 420 *contour.*

Q. *What is the vertical interval of the map?*

Q. *Can you see St. Joseph's College from Four Points?*

Q. *Can you see Emmittsburg from Longs?*

Q. *Can you see Longs from Thomas Creek Church?*

Q. *Can you see Cumps Mill from St. Joseph's College?*

Q. *Draw a profile from road fork* 481 *at Long's to Thomas Creek Church.*

Q. *Your command is bivouacked south of Longs. Where would you post a support of one platoon to observe to the north? Where would you locate the sentinel posts?*

Q. *How would you go from Four Points to Cumps Mill without being observed from the enemy observation post at St. Joseph's College?*

Q. *Where is the lowest point on the map?*

Q. *Where is the highest point on the map?*

Q. *What is the difference in elevation of the*

Clagett farmhouses and the cross roads at Fairplay?

Q. *Where is the first point south of Fairplay on the Fairplay-Emmittsburg road where you come in sight of Emmittsburg?*

Q. *What is meant by the figures* 462 *just northeast of road* 443?

Q. *What is the elevation of Thomas Creek Church; Rose Hill Farm; Cumps Mill; Stull; Rhodes Mill; Ovendorf farmhouse?*

Q. *Where is the highest point on the road between Emmitsburg and Fairplay? On the Emmitsburg–*410–422–438-*road? On the Four Points–*365–418–387–*Motters road?*

Q. *Where is the highest point in the north half of the Emmitsburg sheet? The south half? Where is the lowest point in each?*

Q. *Draw a profile along a line from road fork* 488 *at* 342.5–735.4 *to road fork* 483 *at* 339.7–737.9.

VISIBILITY

Q. *You are standing at road fork* 481 *at Longs. Your eye is* 5 *feet* 6 *inches above the ground. The trees on hill* 463 *are* 20 *feet high. What would be the height of a flag pole at road fork* 418 *to be visible to you?*

Q. *You are at road fork* 445 *at Motters. Can you see St. Joseph's College?*

Q. *You are at road fork* 445 *at Motters. Your eye is* 5 *feet* 6 *inches above the ground. How high would Martin's Mill (building) have to be to be visible to you?*

Q. *You are at Thomas Creek Church. Can you see Emmitsburg? Can you see Cump's Mill? Can you see Motters? Can you see the bridge over the Monocacy River near the Stull farm?*

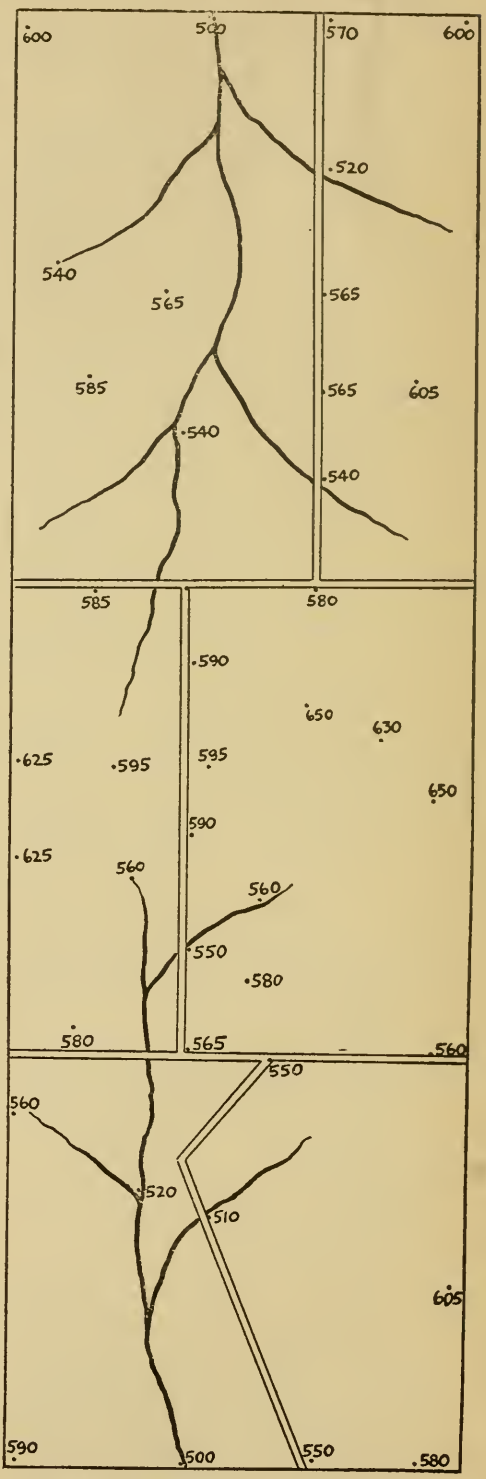
MISCELLANEOUS

Q. *You have been ordered to make a sketch of the country bounded by lines running as follows:* 437–402 *thence to* 449, *thence to Thomas Creek Church, thence back to the initial point* 437.

a. *Where would you locate your base line?*

b. *What points would you use for intersection stations and what points would you locate by intersection?*

Q. *Your company is at the Orendorf Farm on the Emmitsburg Turnpike. You are ordered to march to Fairplay as escort for a wagon train heavily loaded with ammunition. The decision as to the road that you would take is left to you. What road would you take?*



DRAW IN THE CONTOURS ON THIS MAP.

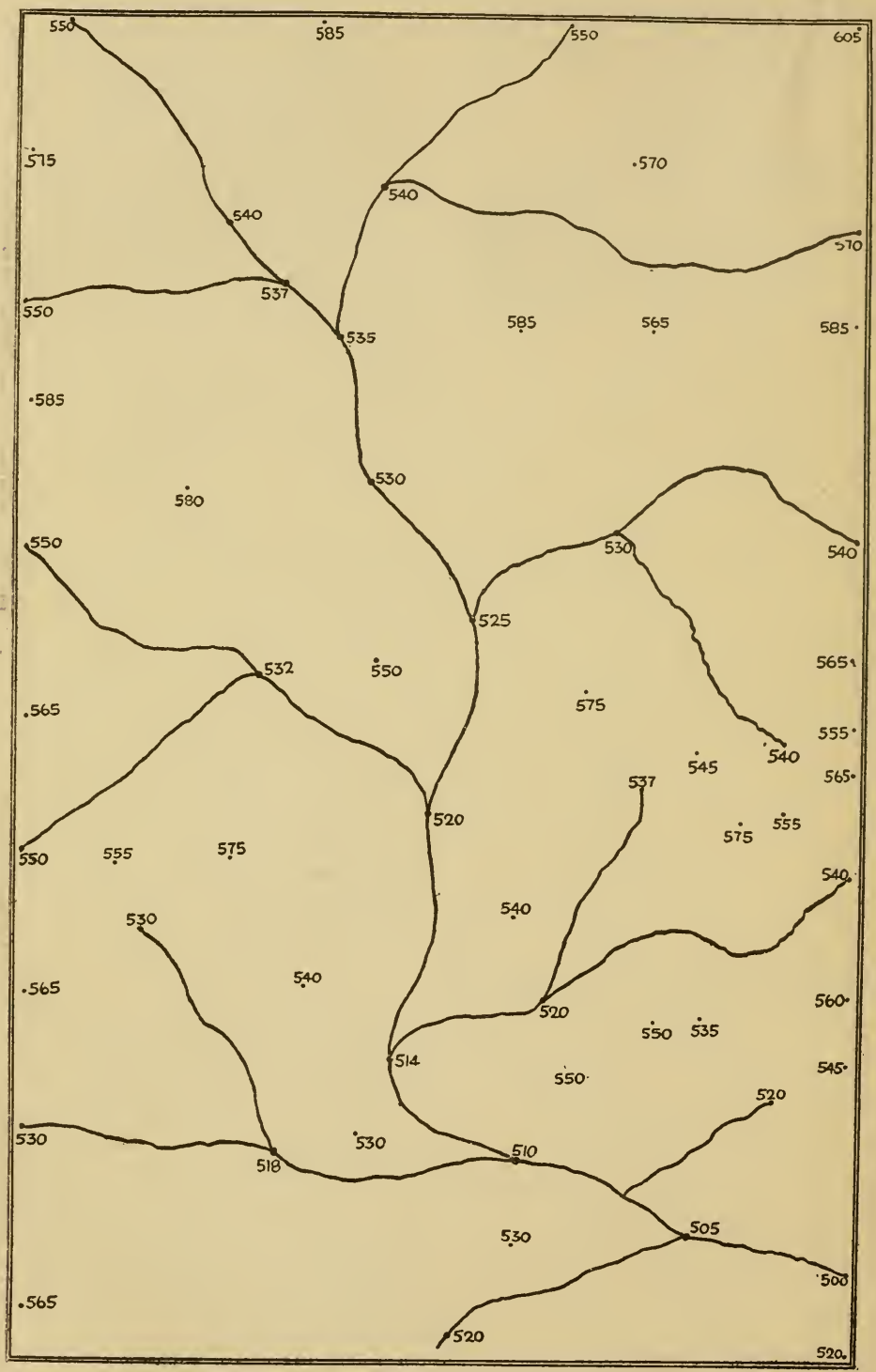
Q. You are at Motters. What is the direction of the following points: Cumps Mills; Four Points; Carricks Knob; the mouth of Toms Creek?

MISCELLANEOUS

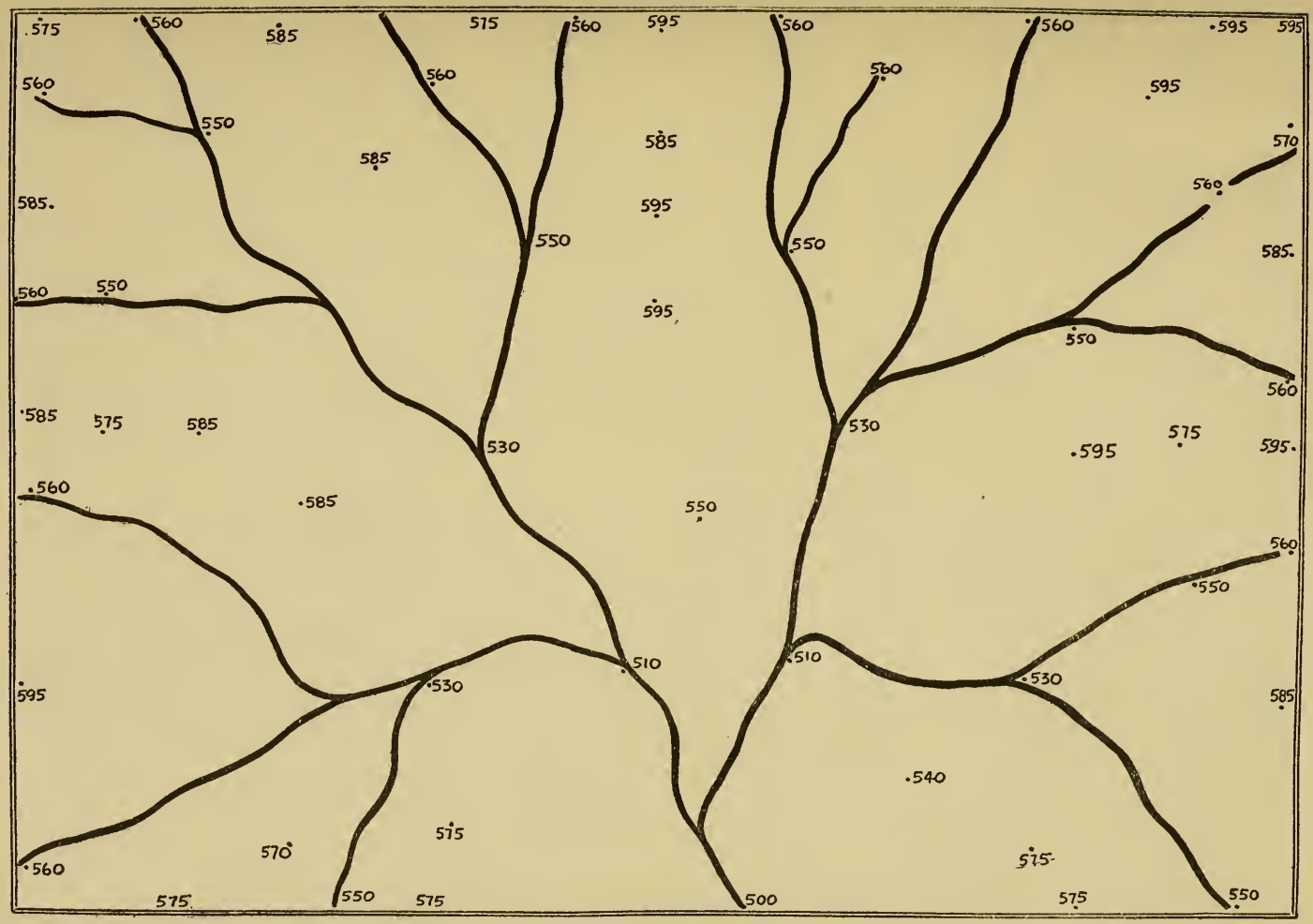
Q. At what point would you disable the railroad between Emmitsburg and Motters?

Q. You are commanding the advance party of an advance guard (one platoon) marching north on the 408–446–472–453 *Emmitsburg road. The head of your platoon is at road fork* 481. *The point is on ahead about* 150 *yards. At this moment a signal to halt comes from the rear. A runner from the captain tells you that the halt is to be for two hours. Where will you post march outposts?*

Q. You are in command of a truck train of 100 *motor trucks. You are ordered to transport* 1,500 *men from Motters to Fairplay and then return to Motters for another* 1,500 *men. All roads on the map are available. How would you route your train?*



Draw in the Contours on This Map.



Draw in the Contours on This Map.

Sketching with Scale of Horizontal Equivalents[1]

The scale of Horizontal Equivalents is based on the fact that at a slope of plus one degree the ground will gain an elevation of one foot in every 57.3 feet. Thus, where a vertical interval of 20 feet is being used, these 20 feet in elevation will be gained in a distance of 20 times 57.3, which is 1,146 feet; where the slope is 2 degrees the 20 feet in elevation will be gained in ½ of 1,146 feet, which is 573 feet; where the slope is 4 degrees the 20 feet in elevation will be gained in ¼ of 1,146 feet, which is 286 feet, etc.

From this data we are able to construct a scale of horizontal equivalents for any degree of slope by first constructing a simple reading scale and taking therefrom the distances as above indicated.

We do not, however, have to go through all of this process because it has already been done for us. The scale of horizontal equivalents that is published herewith is constructed on the normal scale for maps prescribed by the Field Service Regulations as follows:

For road maps and sketches, 3 inches = 1 mile; vertical interval, 20 feet.

For position and outpost maps and sketches, 6 inches = 1 mile; vertical interval, 10 feet.

This scale is graduated from ½ degree to 10 degrees and will be found sufficiently accurate for all practical purposes.

Having determined the elevation of the initial station and plotted the distance from this to the next succeeding station, all you have to do to determine where the contours cross your line is to apply the scale of horizontal equivalents for the degree of slope determined and dot off the contour points.

There is also published a scale from which you may secure a scale of yards with which to draw the sketch from the data given below:

THE PROBLEM

1. From the data given below draw a road sketch:

General:

Scale: 3 inches equal 1 mile.

(Take off the 36-inch scale at the bottom of the illustration on page 21.)

Vertical interval: 20 feet.

Tupper Creek is sparsely lined with trees without underbrush throughout its length within the boundaries of the sketch.

To the south of Tupper Creek there is a low, sparsely wooded ridge generally parallel to the creek, the top of which is about 400 yards from the creek and approximately 100 feet higher.

Tupper Creek is 20 feet wide and fordable except in freshets. The banks are steep and generally from 4 to 6 feet high. All other creeks are less than 12 feet wide.

A telephone line parallels the main road throughout its course within the limits of the sketch.

The K and L. Railroad, single track, standard gauge, runs east and west across the sketch. It is generally parallel to and from 25 to 100 yards distant from the north bank of Tupper Creek. A telegraph line runs parallel to the railroad.

At Station 1.—Elevation 500 feet. Bearing along main road 85°; distance to station 2 is 1,100 yards; slope, minus 1½°.

Bearing right, 175°; distance to Tupper Creek 950 yards; slope for distance of 390 yards is minus 2°, and for remainder of distance is minus 3°.

Bearing left, 5°; distance to top of Grant Hill 750 yards; slope is plus 1½°.

Bearing to mouth of Wind Run, where it joins Tupper Creek, is 122°; this is an intersection bearing.

Station 1 *to Station* 2.—Improved road, barb wire fence on both sides. At station 1 plus 400 yards is the farmhouse of U. N. Picket on the north side of the road. A large barn is 100 yards to north of farmhouse. Grounds are 200 yards square surrounded by smooth wire fence. Trees here and there.

At station 1 plus 600 yards is a barb wire fence, bearing 2°, which runs to the north edge of the sketch. Ground to east of this fence is in corn, west of fence meadow land to Wind Run. All ground to south of road as far south as the railroad and east to Wind Run is in wheat.

At Station 2.—Elevation 410 feet. Bearing

[1] Cut out scale of Horizontal Equivalents on cardboard sheet.

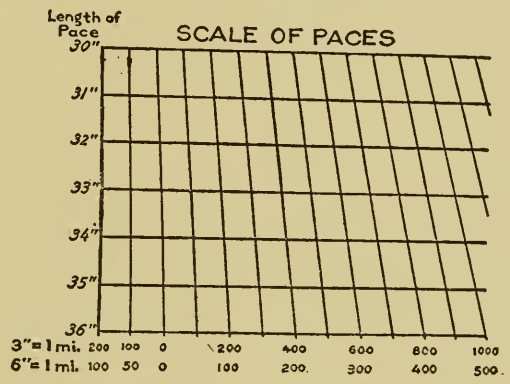
along main road 110°; distance to station 3 is 600 yards; slope, plus 4°.

Bearing right, along Wind Run, 179°. This is intersection bearing to mouth of Wind Run; elevation at Junction of Wind Run and Tupper Creek is 375 feet.

Bearing left, along Wind Run, 1°; distance to north edge of sketch 800 yards; slope plus 1½°.

Road crosses Wind Run on King Post Wooden Bridge 18 feet long, 12 feet wide, and 8 feet above water.

Four hundred yards north of station 2 a small creek bearing 80° runs into Wind Run from the east.



Wind Run averages about 10 feet in width and is fordable throughout its length.

Wind Run is lined with trees throughout its length within the limits of the sketch.

The K. and L. Railroad crosses Wind Run on a stone culvert.

Station 2 *to Station* 3.—Improved road, barb wire fence on north side, smooth wire fence on south side.

From station 2 plus 200 yards to station 3 is an orchard to the south of the road that extends 300 yards to the south, surrounded by a smooth wire fence.

At station 2 plus 350 yards is a farmhouse with a barn. Home of A. B. Fox.

Slopes of hill to north sparsely covered with woods. Remainder of country to south as far as the railroad is meadow land with trees here and there.

At Station 3.—Elevation 540 feet. Bearing along main road 140°; distance to station 4 is 700 yards; slope, minus 3½°.

Bearing (intersection) to left to top of Pope Hill, 50°; slope, plus 4°.

Pope Hill is a ridge running north and south. West slopes sparsely covered with woods; south and east slopes open grass land with trees here and there. The road runs through a cut for a distance of 100 yards on both east and west of station.

Station 3 *to Station* 4.—Improved road, no fences on either side.

At Station 4.—Elevation 400 feet. Bearing along main road 90°; distance to station 5 is 1,050 yards; slope, plus ½°.

Fifty yards to south is railroad station of Camden. Improved road leads from main road to station.

Directly south of Camden Station a small creek runs north and empties into Tupper Creek.

Station 4 *to Station* 5.—Improved road, barb wire fence on each side. From Station 4 plus 200 yards to plus 800 yards is an orchard extending south to the railroad. It is surrounded by a barb wire fence.

At station 4 plus 600 yards to the north of the road is a farmhouse with a barn. Small grove of trees around houses.

At Station 5.—Elevation 430 feet. Bearing along main road 120°; distance to station 6 at Chain Creek is 900 yards. Slope, minus 2°.

Bearing right to Tupper Creek, 180°; distance, 400 yards to creek. Tupper Creek is 70 feet below station 5.

Bearing left along an unimproved road running towards Chain Creek, 45°; distance to Chain Creek, 925 yards; elevation of this road at Chain Creek is 420 feet. Road has no fences. At station 5 plus 300 yards on north side of unimproved road is a farmhouse in a small grove of trees.

Directly south of station 5 a small creek runs north and empties into Tupper Creek.

Station 5 *to Station* 6.—Improved road, smooth wire fence on north side, rail fence on south side.

Entire triangle lying between stations 5 and 6, Chain Creek and the unimproved road running north east from Station 5 is in corn.

At Station 6.—Elevation 330 feet; bearing along main road, 90°; distance to edge of sketch, 600 yards. Road is level and runs between railroad and Tupper Creek generally parallel to both.

Bearing left along Chain Creek 358° to north edge of sketch; slope, plus 1½°.

Chain Creek is 12 feet wide and is fordable. Road crosses on wooden King Post bridge. Railroad crosses Chain Creek on stone culvert. Bearing to right, 45° to top of Garland Hill; distance, 1,000 yards; slope, plus 2°. Junction of Chain Creek and Tupper Creek is 80 yards directly south of station 6.

The south and west slopes of Garland Hill are in grass land with trees here and there.

Map Locations by Coordinates

The method of locating points on a map by means of coordinates is readily grasped if you follow the few simple rules. In fact, once understood, it becomes almost mechanical.

To begin with, a grid is printed on the map as shown on the section of the Emmitsburg map accompanying this text. On maps this grid usually consists of red or blue horizontal and vertical lines, regularly spaced according to the scale of the map. On the section of map herewith these grid lines are in heavy black. For reference, they are always numbered left to right and from bottom to top, beginning at the lower left-hand corner of the map. On the Emmitsburg sheet, the lines are exactly one thousand yards apart.

A point at the intersection of any two of these lines is designated by joining the reference numbers of the two lines by a hyphen, the number on the end of the vertical line being written first. Thus, the intersection of the two lines 339 and 728 would be written 339–728. Now, since there is only one vertical line ending in 39 and one horizontal line ending in 28, there can be no confusion if the first figure of each numeral is omitted, thus (3)39–(7)28, or 39–28, or still more simply 3928.

Reversing the operation, suppose that it is desired to find the intersection that has been designated as 3929. Only one of the vertical lines ends in 39, namely, 339; only one of the horizontal lines ends in 29, namely, 729. The desired intersection is therefore where these two lines cross—just east of Lime Kiln.

It is, of course, necessary to designate points which do not fall at the intersections of the grid lines. For this purpose, fractional parts of the distance between the grid lines are used. These fractional parts are always measured from the lower left-hand corner of the square in which the point is located. For example: assume that it is desired to designate a point in the exact middle of one of the squares. Such a point is halfway between two of the vertical lines and halfway between two of horizontal lines. Let us take the point A. It is halfway between the vertical lines 338 and 339, hence is 338½, or written decimally, 338.5; similarly, it is halfway between 727 and 728, and is written 727.5. Expressed as explained above, the coordinates of the point A would be written 338.5–727.5, or omitting the first figure of each numeral and the hyphen, 385275.

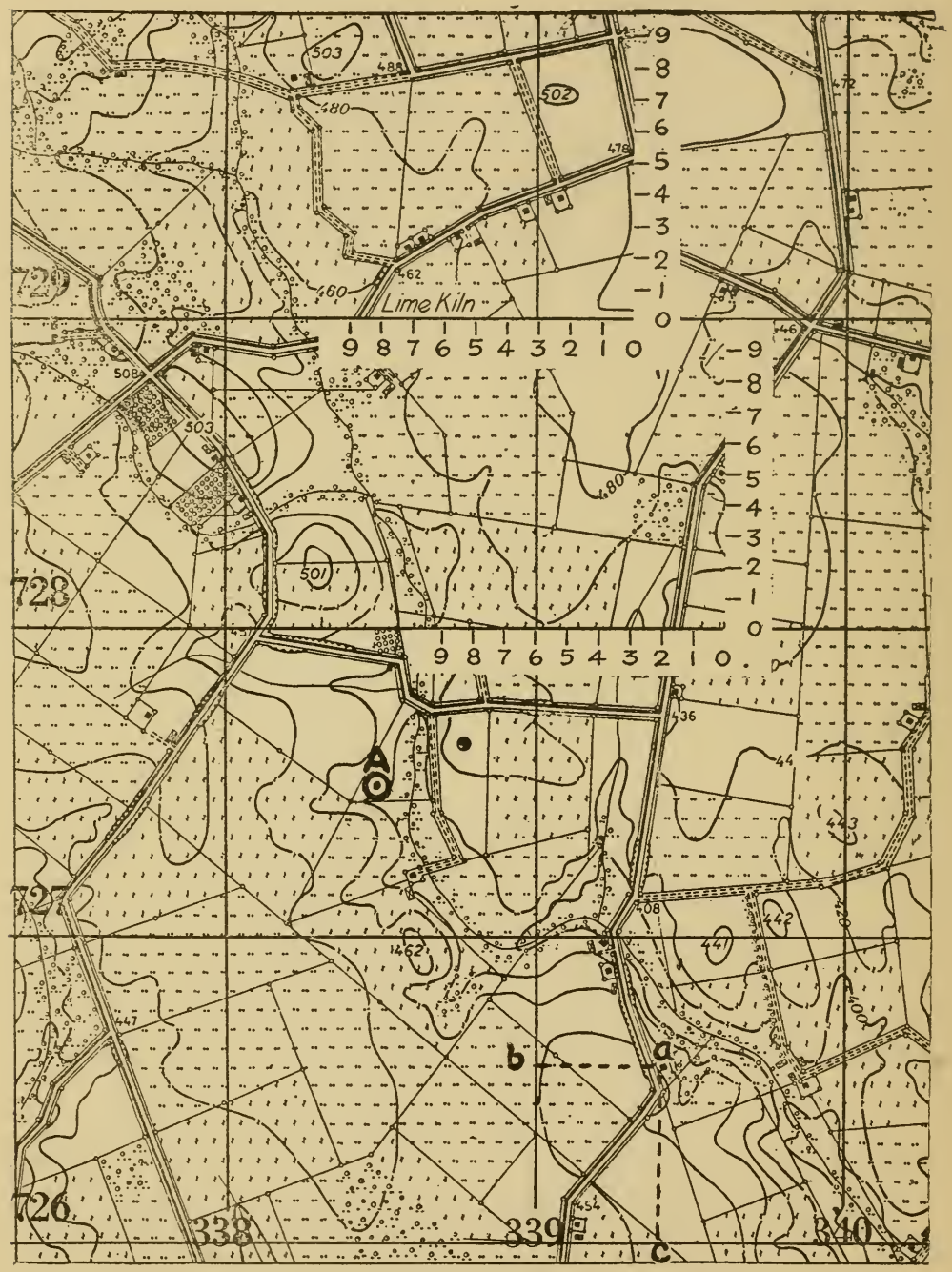
To illustrate how any other point in a square may be located, let us take the house in the square bounded by the vertical lines 339 and 340 and the horizontal lines 726 and 727. To find the coordinates, first draw the dotted line *ab* parallel to 726, then draw a second dotted line *ac* parallel to 339. Now, using the scale at the bottom of the map and measuring the distance from the intersection of the two lines to *c*, we find it to be four-tenths. It is therefore written 339.4. Similarly, measuring to *b*, we find it to be six-tenths. It is written 726.6, and the coordinates of the point are 339.4–726.6, or 394–266.

To avoid the necessity of drawing lines on the map and to facilitate measuring, use is made of a scale such as shown in Fig. 1, cut from stiff paper or celluloid. Each leg of the scale is the same length as the side of one of the squares, and each is divided into ten equal parts. These divisions, representing in this case one hundred yards, are numbered from the intersection of the legs outward as shown in the figure.

Using the scale to find the coordinates of any point, such as the house in the square bounded by the vertical lines 339 and 340 and the horizontal lines 728 and 729, place the scale on the map as shown, one leg parallel to and along the horizontal line 728. Slide it along the horizontal line until the vertical leg passes through the house. Now read the horizontal leg. In this case it is 339.6. Write it down as described, 396. Now read the vertical leg. It is 728.5. Written as described it is 285. The complete coordinates of the house are therefore 396285.

To reverse the operation, let us locate on the map a point whose coordinates are written 393295. Looking at the first, second, fourth and fifth figures, we see that the point must be in the square whose lower left-hand corner is at the intersection of the lines 339 and 729. Placing the zero of the scale at this intersection and sliding the scale along the line 729 until the reading 3 is at the intersection, then reading up the vertical leg until we come to the reading

[1] Cut out coordinate reading scale on cardboard sheet.



12

Reduced from 12 in War Game Map,
By the Engineer Dept, Army Service Schools,
Fort Leavenworth, Kas.

1000 500 0

5, we locate the desired point at the road fork 478.

The system of coordinates we have just described is sometimes designated as six-figure coordinates. In using this method of designating coordinates, the French discard the first two figures of each numeral, retaining only the last figure of each numeral and the decimal. Thus, under the French system, the coordinates of the road fork at 478 would be 339.3–729.5. Eliminating the first two figures of each numeral, we have 9.3–9.5, or leaving out the hyphen and decimal points, 9395.

This can be done without danger of confusion provided the final figure in the reference numbers of the vertical and horizontal lines does not appear more than once on the map. This means that the number of grid lines must not exceed ten each way. If there is a greater number, there will be confusion. For this reason, it is safer to make use of the six-figure coordinates.

Problems[1]

Map: Emmitsburg Sheet

Q. Give the coordinates for the following points: The crossroads at Fairplay; road fork 437, *east of Thomas Creek Church; Cumps Mill; Rose Hill farm.*

Q. A message gives the location of the front lines as follows: 345.2–730.7; 345.2–732.4; 345.6–732.4; 345.7–733.5; 345.3–733.6; 344.9–734.4. *Locate the line on the map.*

Q. A message gives the location of an enemy's battery at 342.2–735.4. *Locate it on the map.*

Q. Locate the 383–420–*Thomas Creek Church–Martins Mill–Four Points–*365–405–468–453 *road by means of coordinates.*

Q. Your patrol advanced by the following route: 340.2–730.9; 341.0–731.5; 342.3–731.5; 342.9–731.2; 353.1–732.4; 343.5–732.4; 344.5–732.5; 345.3–733.2. *Locate the route on the map.*

Q. Messages have been received at Army Headquarters giving the following points on the enemy's line. Indicate on the map where you estimate it to be: 343.5–729.1; 343.2–729.6; 342.7–730.1; 342.6–730.6; 342.9–731.1; 343.1–732.5; 342.4–733.5; 341.3–734.5.

Q. An aviator reports an enemy battery going into position at 341.2–730.5. *You are at* 343.2–731.7 *with your machine gun platoon. What would you do?*

Q. You have a platoon of machine guns concealed in the edge of the woods at 345.4–735.4. *An enemy infantry column is reported marching north on the* 346.0–732.7 – 346.2 – 733.4 – 346.1–735.3 *road. The head of the support of the advance guard is at* 346.3–734.7. *You decide to open fire. What range will you give your gunners?*

Q. The line of resistance of your outpost extends along the line 449–*Thomas Creek Church–*420. *How would you define this line in a message, using the system of coordinates?*

Q. Locate the following points by coordinates: The bridge over the Monocacy northwest of Stull farm; Rhodes Mill; St. Mary's College; Clagett farmhouse; Cose farmhouse.

[1] Cut out coordinate reading scale on cardboard sheet.

Problems

Map—See Page 27

SCALES

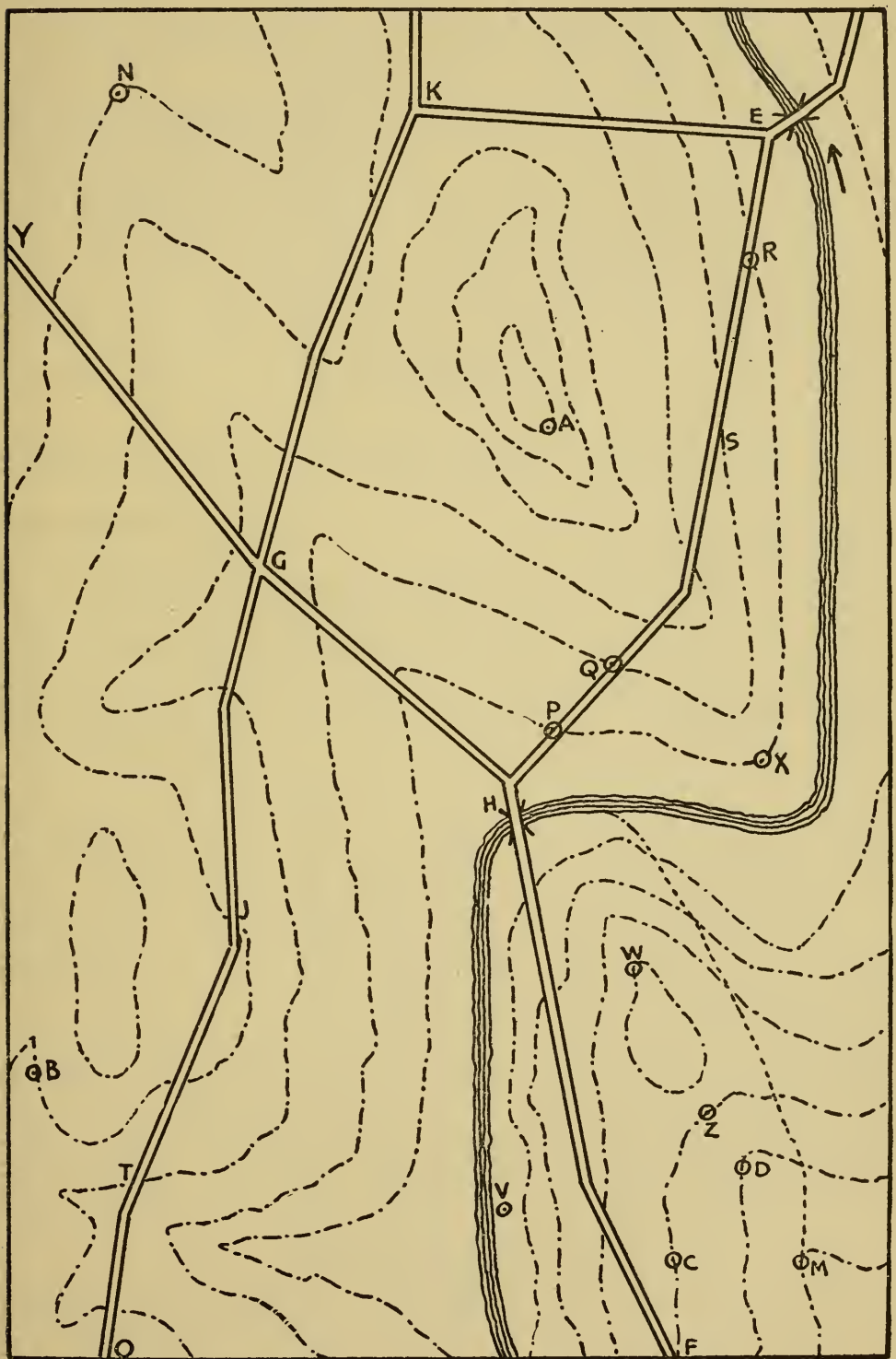
1. *The distance from A to the center of the bridge at E is* 1,800 *yards. Construct a scale of yards for the map. What is the R. F.?*
2. *How long would a force marching at the rate of* 88 *yards per minute take to march from T to the bridge at E via G and H? R. F. of map is* 1:21120.
3. *If the scale of the map is* 6 *inches to one mile, what is the range in meters from A to B; A to C; M to J?*
4. *The head of an infantry column crosses the bridge at E at* 9.05 *a. m. What time will it reach F? Scale of map* 1:10000.
5. *A cyclist traveling at the rate of* 12 *miles per hour takes* 3½ *minutes to go from R to S. Construct a scale for the map to read quarter miles.*
6. *Sound travels at the rate of* 1,100 *feet per second. How soon afterwards will the report of a rifle fired at A be heard at D and N respectively. R. F. of map is* 1:20000.
7. *An aviator traveling in a straight course from M to K at the rate of* 60 *miles per hour passes over M at* 7.35 *a. m. What time will he pass over K? R. F.* 1:50000.
8. *The scale of the map is* 6 *inches to* 1 *mile. You have a machine-gun platoon at A. What range would you give your gunners to the cross roads at H?*

CONTOURS

1. *If X is at an elevation of* 520 *feet and A is* 570 *feet, what is the vertical interval?*
2. *If the contour at B is* 220 *feet, give the heights of contours cut by a line drawn from D to N. The V. I. is* 20 *feet.*
3. *What is the height of D, J, and A, if the height of R is* 100 *feet and the vertical interval is* 20 *feet?*
4. *Examine the road E–H–G–T. Where is the gentlest and steepest slope?*
5. *Indicate the numbering of the contours on a line down from E to G. Height of M is* 240 *feet. The V. I. is* 20 *feet.*
6. *Assume the heights of A and B to be* 520 *feet and* 480 *feet respectively. What would be the heights of J. D, N and E?*
7. *An aviator flies* 1,800 *feet above B and travels in a straight line across the map. At what height will he pass over the bridge at E which is* 10 *feet below the adjacent contour? The V. I. is* 40 *feet.*
8. *State whether the following slopes are concave or convex: A to H; A to E; H to C; U to H; D to V.*
9. *Can a man standing at A see others at H; E; C; K; B; T?*
10. *Are the following points visible from W: U, R, B, N?*
11. *Is E visible from H; D from G; B from A; U from R; V from X; N from S; D from H?*
12. *Show where a line of light from M through W would strike the ground.*
13. *A scout from the north reaches the point N. Will he be able to see the bridge E; bridge H; a house* 15 *feet high at B; a wall* 10 *feet high at T; a signalman at Q?*
14. *What must be the height of a post at P to be visible from C?*
15. *At what point would you establish a signal station to communicate with H, X, E, K and G?*
16. *At what points would signal stations have to be established to communicate between B and E by visual signaling?*
17. *Draw a profile on the line X–N. Is X visible from N?*
18. *Suppose the bridge at H to be* 10 *feet below the nearest contour. When will a man come into sight, who is descending to the river by the trail from M, to a scout standing in the middle of the bridge?*
19. *When an aeroplane was over S a tree at Y was just visible acoss the hill A. At what height was the machine flying above S?*
20. *Two patrols are advancing from E, No.* 1 *via the E–K–G road and the other via the E–H road. When will each come under the observation of a scout located at U?*
21. *Make a section along the line M–K; M–B; E–B; and M–N.*

CONVENTIONAL SIGNS

1. *A single track railroad enters the map at the southwest corner and runs via U, G, and K to the north edge of the map. Draw it in, showing the necessary cuts and fills to keep it level throughout its length. V. I. is* 10 *feet.*
2. *Fill in the following with conventional signs:*
   (a) The village of Kent is at H.
   (b) The ground in the river bottom on the south side of the river south of X is marshy.


N
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D
T
V
C
M
O
F

(c) The underfeature W is wooded.

(d) The ground in the river bottom west of V on the west bank is marshy.

(e) The road between Q and S runs through a cut.

(f) There are trees along the river throughout its entire length.

(g) The triangle K–G–Y is under cultivation.

(h) Between O and T and extending half way to the river is a large orchard surrounded by a barbed wire fence.

(i) There are farmhouses and barns at the following points: R, Y and T.

(j) A telephone line parallels the road F–H–E.

(k) The quadrangle E–K–G–H is cut up into fields by wire fences, and is cultivated. There are trees sparsely scattered throughout the area.

(l) The country east of the H–E road as far as the river is in meadow land with a few trees here and there.

(m) The hill between B and U is heavily wooded.

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